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ABSTRACT

Rather than presenting another major review on research on notetaking from lecture, the purpose of this document is to synthesize the results of this research and to suggest future research directions. First, the historical roots of the current "notetaking from lecture/review" research paradigm are identified. Second, the research on notetaking from lecture and the processes of review is summarized. Such issues as the relative merits of notetaking versus listening, notetaking versus review, instructor's notes versus students' notes, different levels of review, notetaking efficiency, the teaching of notetaking strategies, and the conditions in a lecture that facilitate good notetaking are delineated. Third, a cognitive information processing model of notetaking is proposed. The model is used to critique the research and to propose new directions for research. The main conclusion of the review is that the research had failed to investigate instructionally relevant variables in ecologically valid contexts. A 55-item reference list is appended. (Author/ABL)

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A Review of the Research on Notetaking from Lecture: Some New Directions to Investigate

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A Review of the Research on Notetaking from Lecture:
Some New Directions to Investigate

Over the past 15 years much research has been conducted on the relative value of taking notes from lecture compared to the relative value of having notes for review. In fact, almost all of the research on notetaking from lecture has focused on aspects of these two functions. DiVesta and Gray's (1972) distinctions between the "encoding" function of notetaking (the recording of notes) compared to the "external storage" function (the reviewing of notes) set the stage for the preponderance of research on these topics.

From a theoretical perspective, the research has usually been guided by one of four models: the "levels of processing" model (Anderson, 1970; Craik & Lockhart, 1972), the "principle of encoding specificity" (Tulving & Thomson, 1973), the "transfer appropriate processing" model (Morris, Bransford, & Franks, 1977), and the "generative" model of learning (Mayer, 1975, 1984; Wittrock, 1974).

The "levels of processing" model suggests that information is processed at different levels of understanding and that deeper levels of processing are inherently better than surface levels of processing. Superior learning and long term memory are aided by deep level processing. The "principle of encoding specificity" and the "transfer appropriate processing" models propose that the optimal level of processing should be commensurate with the level of information to be tested. Thus, deeper level processing is not inherently advantageous if the terminal task requires surface level processing. The "generative" model posits that effective learning occurs when the learner is able to relate new information to existing knowledge. Further, the "generative" model recognizes that numerous cognitive processes are involved during complex learning.

The purpose of this paper is to synthesize the results of the research and to suggest new research directions. Another broad review of the research on notetaking from lecture, however, is not needed at this time. Since 1979, eight major reviews have been conducted (Anderson & Armbruster, 1986; Carrier, 1983; Carrier & Titus, 1979; Hartley & Davies, 1978; Hartley, 1983; Henk & Stahl, 1985; Kiewra, 1985a; and Kiewra, 1985c). These reviews are extensive. And the results from the research are reasonably clear. The major thrust of this paper is to analyze what we don't know about notetaking and to suggest future research directions. To accomplish these goals, the paper is divided into three sections. First, the general research results are briefly presented. Second, a broad analysis of the current status of the research is highlighted. Particular emphasis in this section is placed on an analysis of the general limitations of the underlying research models that have been used to investigate either notetaking from lecture or the concomitant review processes. Third, some new perspectives on notetaking research are offered. The goal of this paper is not to critique specific studies. Rather, the goal of this paper is to offer a broad research model to generate ecologically valid studies.

A Brief Overview of the Research on Notetaking and Review of Lecture Content:

1. Notetaking vs. Listening:

Numerous variations on this research question have been conducted. The results generally support the proposition that taking notes is better than not taking notes. Kiewra (1985a) reviewed 56 studies. Of the 56 studies, 33 studies favored notetaking, 21 studies found no significant differences between notetaking and listening, and only 2 studies found notetaking dysfunctional. In a comprehensive metaanalysis, Henk and Stahl (1985) concluded that taking notes increases a student's performance from the 50th percentile to the 62nd percentile. This difference represents a +1/3rd S.D. improvement. Henk and Stahl concluded that the process of taking notes, per se, does little to enhance recall. In the Henk and Stahl metaanalysis, the advantage of notetaking was found to be in the review process. Anderson and Armbruster (1986), after reviewing 24 experimental studies, found that 10 experimental studies supported notetaking, while 14 failed to support notetaking (without review). Based on these findings, Anderson and Armbruster analyzed the qualitative differences between notetaking and listening, the lecture effects on notetaking, and the student's purposes for notetaking. Their analysis indicated that students can remember more about main points of lectures than non-notetakers, but probably only if (1) notetaking doesn't interfere with cognitive processing, and (2) the students are able to use the appropriate level of processing while notetaking. The Carrier and Titus (1979), Carrier (1983), and Hartley (1983) reviews all support the usefulness of notetaking.

2. The Relative Importance of Taking Notes from Lecture vs. Reviewing the Notes:

The research is quite clear: having the notes for review is more important than notetaking. All reviews support this finding. In Kiewra's (1985a) review, 17 studies favored review over notetaking, 5 studies found no differences, and no studies found review to be dysfunctional. In the Henk and Stahl (1985) metaanalysis, students who reviewed their notes increased their performance by 1 1/2 S.D. Of the 14 studies reviewed by Anderson and Armbruster, all 14 studies supported the "external storage" hypothesis. While the reviews of the research unequivocally support the "external storage" hypothesis, much equivocation exists about which content students should include in their notes and what type of review students should use to study their notes.

3. The Relative Merits of Instructor's Notes vs. Student's Notes:

College students tend to take incomplete notes. Might not the instructor provide students with a set of notes and instruct the student to listen to the lecture in lieu of notetaking? Kiewra (1985c) evaluated the research on this question. Students who received their instructor's lecture notes performed better than those students who

reviewed their own notes. The best performing students, however, were those students who reviewed both their instructor's notes and their own notes. Fisher and Harris' (1973) study corroborates this finding. Kiewra also concluded that instructors should present a skeletal outline of the lecture to the students to enhance their notetaking.

4. Effects of Different Levels of Review on Test Performance:

The research supports the "principle of encoding specificity" and the "transfer appropriate processing" models of learning. Studies conducted by Barnett, DiVesta, and Rogozinski (1981); Carter and Van Matre (1975); Hartley and Marshall (1974); Kiewra (1983); Kiewra (1985c); Kiewra and Benton (1985); and Shimmerlick and Nolan (1976) all support these models. While these studies support the general model, very little specific recommendations can be made to students about how to review notes. As Kiewra (1985a) has noted, the research has not been designed to provide students with specific advise how to review notes. The researchers must now investigate the efficacy of specific review techniques. Unfortunately, each of the above researchers investigated different subtle applications of encoding specificity and transfer appropriate processing, thus making specific recommendations impossible.

5. Effects of Different Levels of Notetaking on Test Performance:

As with the previous question, researchers cannot make specific recommendations about levels of notetaking. Kiewra (1985a) concluded that students can control the depth of notetaking under certain circumstances. The effects of different levels of notetaking, however, are open to research. Such issues as the extent to which instructors can teach different levels of notetaking and the extent to which students can use deeper levels of notetaking with quick-paced and information-dense courses needs further investigation.

6. The Role of Test-Expectancy on Taking Notes from Lecture:

Does expectancy of the test format or content influence the student's notetaking behaviors? The results are equivocable. Barnett and Freud (1985) and Kiewra and Fletcher (1984) found that students tend to take verbatim notes rather than conceptual notes. In an experimental study, Barnett, DiVesta, and Rogozinski (1981) found that if students were instructed to listen for key ideas and to take outline notes their notetaking behaviors improved. Certainly the pace and information density of a lecture greatly influences a student's notetaking strategy. Rickards and Friedman (1978), for example, found that knowledge of test mode did not effect the quantity of notes nor did it effect test performance.

7. Effects of Prior Content Knowledge on Notetaking Performance:

Only a few studies have investigated this question. Peper and Mayer (1978, 1986) found that notetaking served a generative function. If the learners were deficient in prior knowledge of the content, they

performed better on far transfer tasks than non-notetakers. The non-notetakers performed better on near transfer tasks. If the learners had adequate prior knowledge, however, the learners did not increase their generative processing nor their far transfer achievement. Barnett and Freud (1985) found that notetakers achieved more than non-notetakers on a transfer task.

8. Notetaking Efficiency:

Efficiency can be evaluated at least three ways. First, the number of informational units in a lecture is matched to the number of informational units in the student's notes. Second, a ratio is computed between the number of units in the student's notes compared to the number of words the student used to record the units. Third, can the student make sense out of the notes immediately after the lecture or when the student wants to review the notes?

Kiewra (1984) found that the number of notes taken over a 4-week period correlated .78 with the lecture content and .61 with performance on the course exam. Howe (1970) indicates that the number of words in relation to the informational units is the key to effective notetaking. The lower the ratio the better, as long as the integrity of the information is maintained. Both Locke (1977) and Aiken, Thomas, and Shennum (1975) found that note completeness is the key to successful exam performance, provided the student reviews the notes appropriately.

The best advice for a student at this time is to tell the student to record all the important information. The only exception to this might be if the notetaking interferes with understanding. In this instance, perhaps the student ought to record such information as names of people, words, and dates and then fill in the critical information after class by talking to other students or the instructor.

9. Individual Differences and Notetaking Efficiency:

Although only a few studies have investigated the relationships between individual differences and notetaking efficiency, some interesting generalizations emerge. The earlier studies (Berliner, 1969, 1971; DiVesta & Gray, 1973) found that students with low working memory capacity had difficulty taking notes from lecture. More recently, the work of Kiewra and Benton (1985) and Kiewra, Benton, and Lewis (1985) found that students deficient in working memory control processes recorded fewer words, fewer ideas, and fewer subordinate ideas. Much research needs to be conducted on ATI differences. Specifically, to what extent can students learn strategies to increase their efficiency, particularly if the student is low in working memory?

10. To what extent can notetaking and review strategies be taught to students?

Kiewra (1985a) summarizes the research succinctly in this area. "Little advice can be offered to advise a student how to take and to review notes." As indicated in the first part of this paper, most

researchers have focused on the relative aspects of the process and product function of notes. The few studies that have attempted to train students such as Kiewra and Fletcher (1984), or Barnett, DiVesta, and Rogozinski (1981), have not trained students extensively with specific strategies. Rather, the strategy training has been general in scope. Thus, much research must be conducted on specific strategy training.

11. What are the conditions of a lecture that facilitate good notetaking?

a) Rate:

The following lecture rates have been noted in various studies:

Study	Finding
Kiewra (1985b)	Pace varied from 45-240 wpm.
Maddox & Hoole (1975)	Fastest lecture was 114 wpm.
Fisher & Harris (1973)	Slowest lecture was 44 wpm.
Nye (1978)	Pace of 80 wpm is appropriate.
Ladas (1977)	Rate beyond 135 wpm is too fast.

b) Informational Density:

In a study involving 12 different courses, Locke (1977) reports that the informational density varied from 45-164 units in a 40 minute lecture. Given that courses vary considerably in density, more research needs to be conducted on the relationships between density, pace, and notetaking efficiency. For example, a 135 wpm rate in a highly information dense course is considerably different that a 135 wpm rate in a low information dense course.

c) Lecturer's Purpose and Students' Ability to Identify Critical Information:

Most studies report that students record approximately 50-60% of the important content of a lecture (Crawford, 1925; Hartley & Cameron, 1967; Locke, 1977; Maddox & Hoole, 1975; and Nye, 1978). Conditions that increase the likelihood that students will record information include the use of the blackboard, numbered points in a lecture, signaling important information, and restating the information.

d) Levels of Information Within a Lecture:

In an unpublished study, Kiewra (1986) indicates that students record up to 90% of level #1 information, 60% of level #2, 30% of level #3, and only 11% of level #4 information. Thus, lecturers must alert students of supporting detail and provide the students the chance to record the supporting details of the lecture.

Analysis of the State of the Research: A Cognitive Perspective:

Although much research has been conducted on notetaking and review of lecture notes, it is fair to say that little prescriptive information is available to advise students specifically how to take notes from lecture or how to review the notes. Most researchers were concerned with the process/product functions of notes as originally proposed by DiVesta and Gray (1972). Rarely were studies conducted to evaluate the different cognitive processes and strategies associated with notetaking or review. Most often, the "levels of processing," "encoding specificity," "transfer appropriate processing" or "generative" models of learning were used as a framework for the research. While all these models are cognitive in scope, the models lack the specificity necessary to evaluate the different cognitive activities associated with notetaking and review. It appears as if much of the research was conducted to evaluate the validity of these general theories or hypotheses in relation to notetaking or review rather than evaluate those cognitive processes and strategies actually required for successful notetaking and review. In the opinion of the author of this paper, the following outcomes have occurred as a result of this research framework.

1. Throughout this period, we have operated without a significant model of autonomous learning. Rohwer's (1984) admonition summarizes the problem well:

> If studying is indeed of such importance, one would expect that educational psychologists by now would have made it a major object of theory and research, on a par with such topics as teaching and instruction. To the contrary, however, a coherent and visible psychology of studying has not been forged.

At a more specific level, we lack a coherent model of notetaking and review. Since we lack a coherent model of what a learner must do to convert lecture information into knowledge and then use the knowledge on a test, we have failed to research these cognitive activities. Consequently, much of the research lacks instructional applicability.

2. Since we lack a coherent model of notetaking and review, the following variables have rarely been systematically investigated:

a) the characteristics of the information presented in the lecture (i.e., the different types of information processing demands associated with declarative knowledge and procedural knowledge). This area has particular utility and is discussed in the next section of the paper;

b) those stimulus characteristics in the lecture that indicate which information is important, given that the lecturer does not specifically emphasize the important information;

c) the task demands of the test;

d) the cognitive processes and possible review strategies associated with different declarative and procedural knowledge tasks;

e) the instructional validity of different notetaking systems (e.g., Cornell method, mapping, charts, informational matrices, etc.);
f) the cognitive demands and possible coping strategies associated with rapidly paced, information-dense lectures;
g) the application of the expert-novice paradigm to notetaking and review;
h) the relationship between individual differences and the use of effective strategies;
i) the notetaking strategies of young students (elementary, junior, and senior high).

3. Most of the research lacks ecological validity. In fact, most of the studies reviewed for this paper possessed one or more of the following characteristics or conditions:
a) The lectures were of a short duration (15-20 minutes);
b) The lectures were videotaped;
c) Students took notes without review;
d) Students listened to the lecture without taking notes;
e) Students reviewed the lecture content immediately after hearing a short lecture;
f) Students were never required to integrate lecture and textbook information;
g) The research study was rarely conducted in a course;
h) Students were not required to integrate a series of lectures. Thus the span of information was almost always small in scope);
i) The students were not allowed to interact with the lecturer or with other students. (Experimental design procedures would have been violated.) This design, however, precluded the opportunity for students to clarify points, ask questions or receive feedback;
j) Because of the design of the studies, academic motivation and important metacognitive variables were not investigated;

In summary, the experiments have failed to evaluate the relationships between the characteristics and content of the lecture, the cognitive processes necessary to convert information into knowledge, the review processes, and the task demands of the test. This lack of integration affords us with little useful information about how students should take notes or review content.

4. Researchers have rarely investigated specific strategy training. Perhaps we have not developed systematic strategy training programs because we lack a clear conceptual understanding of how students should take efficient notes and how students should review the notes. Thus, the rudiments of any research program must consider the relationships between the information to be processed, the students' content knowledge, the notetaking and review strategies, and the task demands of the test. In this model, integrity is maintained between the three major components. The student must convert the important information into usable knowledge necessary to perform well on a test. See Figure I for an overview of the components. A detailed model and discussion is presented in the next section.

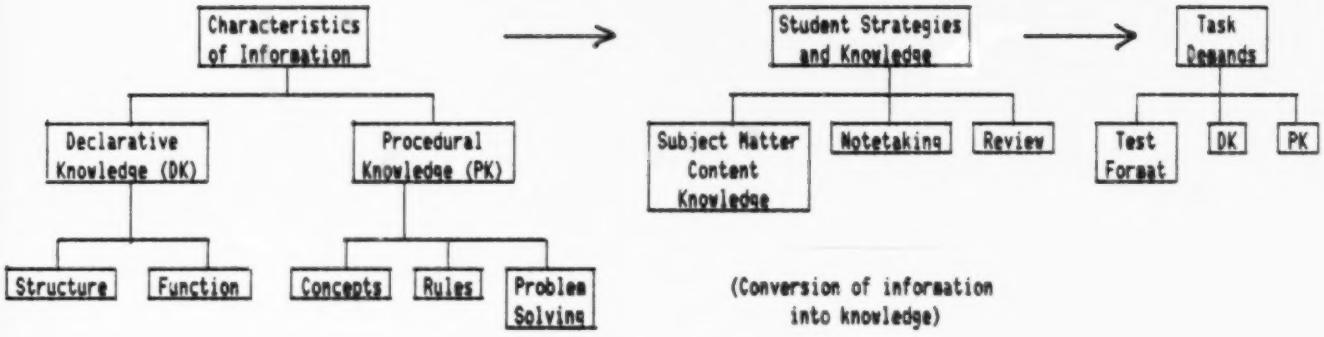

Figure I. The Rudiments of an Information Processing Model

5. Many of the research studies have assumed that students know how to take quality notes and how to review effectively. Many of the students may use inadequate strategies or even deleterious strategies. Further, students vary significantly in their notetaking and review strategies. Given these circumstances, all we can conclude, at best, is that the results of most of the studies apply only to relatively naive, untrained students. Until studies are developed that require naive students to use specific strategies, and then monitor the students' performances to insure that they use the strategies, we cannot make many instructionally useful prescriptive recommendations.

6. All four of the cognitive models that have guided the notetaking/review research posit that either under all conditions or under selective conditions the student must actively process information at a deep level of understanding. Two major problems must be considered. First, these models are heuristic. The models lack precision. What is meant by deep level processing? What strategies qualify for deep level processing? How many levels are there? Under what circumstances should students use "shallower" level processing? Second, even if these questions are adequately answered, how realistic is it to assume that students might use deep level processing in typical lecture conditions? Such issues as motivation, information density, pace of the lecture, and fatique all need to be considered. When researchers inspect students' notes, generally the researchers find that students take verbatim notes. To what extent can we train students to use deep level processing under normal lecture conditions?

7. Investigating the review processes of a student when the student uses his/her own notes presents a serious research difficulty. The review process is only as good as the student's notes. If the student has recorded a poor set of notes, the student will be unable to effectively review the lecture content. To make definitive conclusions about the relative worth of review processes, however, is tenuous unless the quality of the student's notes is inspected. Obviously, in a real course situation the student might use other students' notes, consult with other students, consult with the instructor, or consult textual sources to enhance the notes and to enhance the review process.

8. Because of the nature of the research on notetaking and review over the past 15 years, motivational and metacognitive variables have not been investigated. Research on metacognitive variables, such as that conducted by Biggs (1985), Brown, Campione, and Day (1981), and Pressley, Borkowski, and Schneider (1986), needs investigation. Particular emphasis should be placed on the student's awareness of patterns of information at a metaschema level. This suggestion is fully developed in the next section.

The Rudiments of a Cognitive Model of Notetaking and Review: Selected Research Implications

The purpose of this section of the paper is to present a cognitive model of lecture notetaking and review. The model draws heavily from recent work on metacognition, schema theory, and selected information processing models. In part, the model in this paper is a modification and extension of the work of Rohwer and Thomas (1986). Rohwer and Thomas propose that a theory of autonomous learning should consider student characteristics, course characteristics, study activities, and study outcomes. To complete the model, Rohwer and Thomas posit five cognitive transformational activities (selection, comprehension, memory, integration, and cognitive monitoring) and three self-management activities (time management, effort management, and volitional monitoring). The effective student is viewed as having gained control of all these components of studying.

Figure II extends the Rohwer and Thomas models by identifying those factors directly related to notetaking from lecture and review. The purpose of this model is to highlight selected environmental characteristics, student characteristics, and cognitive processes a researcher should consider to develop an instructionally prescriptive research model of notetaking and review. Six supravariables are identified.

I	II	III	IV	V	VI
Presage Variables	**Information Processing Demands**	**Pre-notetaking Variables**	**Notetaking Variables**	**Review Variables**	**Testing Variables**
I. Personal characteristics A. Metacognition B. Motivation C. Domain knowledge D. Learner strategies E. Cognitive abilities F. Learner styles	I. Individual differences A. High-low B. High-low C. High-low D. High-low E. High-low F. 1) Field independent-field dependent 2) Deep surface-level surface 3) Organized-disorganized	Surveying (repeatable schemas) Reading content Establishing test expectancy Establishing intent/mood Awareness of possible schemas, scripts, and themes	Selective attention Pattern recognition Internal representation Decode information External representation Integrate chunks of information Organize information Elaborate information Determine notetaking system Control daydreaming Control competing stimuli	Declarative knowledge (various comprehension and memory strategies) Procedural knowledge Concepts Rules Problem solving (various practice strategies)	Format Declarative knowledge items Procedural knowledge items
II. Situational characteristics A. Non-content lecture characteristics B. Content lecture characteristics C. Lecture characteristics	II. A. Pace, density, degree of student interaction, visuals, enthusiasm B. Vocabulary, length of sentences, "alert words" C. Declarative knowledge or procedural knowledge				

Figure II. A Proposed Model for Investigating Notetaking and Review Processes

1. Presage variables: The presage variables include those broad personal characteristics of the learner and the lecture situation thought likely to have an effect on notetaking and review. Personal characteristics refer to metacognition, motivation, domain knowledge, functional and dysfunctional learner strategies, cognitive abilities, and learner style variables. Situational characteristics include the lecturer's mannerisms, the non-informational content of the lecture, and the lecture content. The non-informational content of the lecture includes such factors as lecture pace and density, vocabulary choice, length of sentences, and the organizational structure of the lecture. Lecture content refers to the type of declarative and procedural knowledge content the lecturer presents to the class.

2. Information Processing Demands: Given the presage variables identified above, the researcher needs to investigate how these variables interact to create demands on the learner. The researcher should investigate individual differences in metacognition, motivation, domain knowledge, strategies, and cognitive abilities along a high-low continuum. Additionally, the researcher should investigate learner style variables, such as field independence-dependence, organized-disorganized, or deep level-surface level processing along a continuum. Finally, the researcher needs to investigate the content in the student's notes and the review processes of the student as a function of the information processing demands of the lecture and the demands of the test.

3. Pre-notetaking variables: In a classroom environment, a student may do many things to prepare for a lecture. These include: (1) surveying the text and previous lecture content to identify important informational patterns, (2) reading the lecture content in advance (to increase domain knowledge), (3) determining the task demands of the test, and (4), purposefully establishing a positive mood for the lecture. All of these factors need investigation.

4. Notetaking activities during lecture: The student must pay selective attention throughout the lecture. Further, the student must identify the important content, decode the content, and record the appropriate information. To what extent can we train students: (1) to record units of information effectively, and (2) to optimally organize the units of information as the lecture continues? The processes involved in recording specific units of information and organizing the information constitutes deep surface processing. Notetaking is a complex cognitive activity. What techniques can we use to teach strategy acquisition? To what extent can the student automatize the strategies? Which individual differences are likely to effect strategy acquisition? Of particular significance is the question of how a student can (1) perceive critical patterns of information in the lecture, (2) determine the appropriate notetaking format for the units of information, and (3) record the information without overloading working memory. And the notetaking must occur while the student comprehends the lecture.

How students convert the lecturer's utterances into a telegraphic and meaningfully organized system of notes needs special consideration. The decisions involved to convert the information into hierarchically organized patterns would appear to parallel the vanDijk and Kintsch (1983) discourse processing model. They postulate that discourse processing requires processing at three levels of complexity: the propositional level, the combining of propositions level, and the macro level. These levels seem analogous to writing telegraphic phrases, combining the phrases, and creating an overall organizational structure to the notes. To what extent do these decisions present working memory difficulties? How might this process become automatized?

Recent work in cognitive science has suggested that each discipline develops its own themes, schemas, and scripts. Themes refer to the major issues or viewpoints of a discipline. Schemas refer to the representation of each topic. Scripts refer to the specialized vocabulary employed by each discipline. At the broadest level, only a few themes exist. This generalization also is valid for schemas. The underlying structure of any topic is usually limited to 5-7 subtopics. Thus, might it not be possible to train students to identify repeatable schemas organized around themes and then train the students to represent those schemas? Examples of this line of research are found in Figure III. The metacognitive research mentioned previously in this paper also applies here. DuBois (1986) is developing a system to teach students how to recognize and construct informational schemas. Although in the early stages of development, the process appears to have great promise.

Author or Study	Types of Schemas or Knowledge Structures
Anderson (1983)	Temporal, spatial, abstract
DuBois (1986)	Hierarchies, sequential, cluster patterns
Graesser & Clark (1985)	Nodes: goal, process, event, state, style Arcs (relationships): reason, outcome, initiate, manner, consequence, implies, property, set membership
Nicholas & Trabasso (1980)	Lexical (who, what); spatio-temporal (where, when); inferential (why, how); and evaluative (so what)
Pines (1985)	Set element relationships, whole-part relationships
Rosch (1978)	Superordinate, base, subordinate
Rumelhart (1975)	Story grammar: setting, theme, plot, resolution

Figure III. Schema or Knowledge Structures

5. Review variables: How should a student schedule review time? When should a student review? What should a student do to review declarative knowledge content and procedural knowledge content? What should a student do if the notes are ineffective? None of these questions have been investigated.

6. Testing variables: To develop a complete model of notetaking and review, we must carefully analyze the information processing demands of the test. Thus the central research question is: Given a lecture with "x" content, and a test with "y" content, what cognitive activities must a student employ to convert the information from the lecture into usable knowledge for the test?

The previous six supravariables need extensive investigation. Additional aspects of a notetaking/review research program should consider: (1) how to train students to spontaneously initiate appropriate notetaking and review strategies (metacognitive and motivational questions), (2) how to train students to transfer strategies to new domains of knowledge, and (3) how to train instructors to improve lecture techniques.

Summary

The paper was divided into four phases. First, the roots of the notetaking/review research were identified. Second, the research findings of the past 15 years were summarized. Third, the state of the research was critiqued. Fourth, based on the status of the research, new research directions were proposed. The major premise of this paper is that researchers should develop integrated research programs to investigate instructionally relevant variables in ecologically valid contexts.

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